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## Conference on ‘Impact of nutrition science to human health: past perspectives and future directions’ Postgraduate Symposium

### Improving adolescents’ dietary behaviours in the school-setting: challenges and opportunities

Lauren D. Devine\* , Alyson J. Hill and Alison M. Gallagher

*Nutrition Innovation Centre for Food and Health, School of Biomedical Sciences, Ulster University, Coleraine BT52 1SA, UK*

Adolescence is a critical time of physical, psychological and social development, and thus, optimal nutritional intakes are required during this life stage. Despite this, adolescence is recognised as a period of nutritional vulnerability, with many reportedly failing to meet current dietary guidelines. The school-setting presents a favourable environment to intervene and promote positive dietary behaviours and is also inclusive regardless of socio-economic status. However, a lack of consensus exists on how best to utilise schools to facilitate improvements in dietary behaviours among this age group. Whilst previous research has focused on identifying the factors motivating dietary choices within the school-setting, less is known on the optimum strategies to enhance these dietary choices which could positively contribute to the design of future interventions. It is reported that adolescents have good nutritional knowledge, although this does not appear to be a central consideration when making their dietary choices. Alternative factors at the individual (taste, visual appeal, familiarity, food quality, price, portion size, value for money, time/ convenience), social (peer influence), physical (product placement) and macro environment (food availability) levels have been frequently cited as important influences on adolescents’ dietary choices in school. Although school-based interventions have shown potential in achieving positive dietary change among adolescents, more research is needed to determine the most effective methods in improving dietary behaviours in schools. This review summarises the key factors which influence adolescents’ school-based dietary choices and the effectiveness of previously conducted interventions, identifying promising components for consideration when developing future dietary interventions within the school-setting.

#### Adolescent: School: Dietary choice: Intervention

Adolescence is a time in life between childhood and adulthood from the age range of 10–19 years<sup>(1)</sup> and can be further categorised into ‘early adolescence’ (10–14 years) and ‘late adolescence’ (15–19 years)<sup>(2)</sup>. The importance of a healthy diet during adolescence to aid in achieving optimal health is well established<sup>(3)</sup> and the school-setting provides

an opportunity to facilitate promoting healthful dietary behaviours among this age group<sup>(4)</sup>. To achieve this, there is a need to better understand what influences adolescents’ dietary choices in school and what recommendations for improvement have been suggested to develop effective and sustainable school-based interventions. Exploring the

**Abbreviations:** HPS, health promoting school; NI, Northern Ireland; SR, systematic review.

**\*Corresponding author:** Lauren D. Devine, email [devine-L7@ulster.ac.uk](mailto:devine-L7@ulster.ac.uk)



impact of school-based nutrition interventions in promoting positive dietary change among adolescents is also an essential consideration for future intervention design to optimise their success.

This review provides an insight into the importance of targeting adolescents' dietary behaviours and why the school-setting is an opportune environment to achieve this. This review also considers key factors which influence adolescents' dietary choices within the school-setting and explores the success of previously conducted school-based interventions, aiming to identify promising intervention components which could be utilised in future interventions to facilitate adolescents' selecting healthier options within this environment.

### Why target adolescents' dietary behaviours?

Adolescence represents a period of significant rapid physical, psychological and social growth<sup>(2,5)</sup>, and thus, optimal nutritional intakes are required during this critical life stage to support this development and facilitate adolescents achieving their full potential<sup>(6,7)</sup>. Good nutrition is widely recognised as essential for current<sup>(8)</sup> and future<sup>(9)</sup> health, with evidence suggesting that dietary behaviours established during adolescence track into adulthood<sup>(10,11)</sup>. Poor dietary intakes during adolescence have been associated with an increased risk of short-term (immediate) health consequences, such as weight gain, reduced academic performance and poor bone mineralisation<sup>(8)</sup>, and the development of risk factors for chronic diseases in later life<sup>(8)</sup>. Despite the importance of optimal nutrition during adolescence and the dissemination of specific nutritional guidelines, this life stage is recognised as a nutritionally vulnerable time<sup>(12)</sup>, with adolescents' dietary intakes remaining suboptimal and failing to meet current nutritional recommendations<sup>(13,14)</sup>. During the transitional phase from childhood to adolescence, adolescents begin to develop their own sense of autonomy, becoming more independent in their dietary decisions and less reliant on their parents or guardians<sup>(15)</sup>. This transitional period and increased autonomy can be associated with less favourable dietary behaviours<sup>(15,16)</sup>. Additionally, social determinants can influence this population's dietary behaviours, with those residing in areas of higher socio-economic deprivation reported to have poorer quality diets than those of higher socio-economic status<sup>(17,18)</sup>. Given that poor dietary habits established during adolescence can track into adulthood<sup>(11)</sup> and become more resistant to change<sup>(19)</sup>, promoting healthful dietary behaviours among adolescents, when these behaviours are still developing, is imperative to reduce the risk of future ill-health.

Moreover, the prevalence of overweight and obesity among the adolescent population is of increasing concern. Overweight and obesity during adolescence is associated with an increased risk of adverse health effects developing in adulthood, such as type 2 diabetes, hypertension, stroke and CHD<sup>(20)</sup>. Adolescent overweight or obesity can also predispose individuals to being overweight or obese in adulthood<sup>(21)</sup>, leading to an increased

economic burden on healthcare systems<sup>(22)</sup>. Whilst obesity rates are reported to be stabilising in children (<11 years)<sup>(23,24)</sup>, obesity rates among adolescents continue to rise globally<sup>(4,23–25)</sup>, further emphasising the importance of targeting health promotion strategies at adolescents. Although adolescence presents an opportune time to intervene and promote positive dietary behaviours to optimise current and future health, adolescents have previously been overlooked in nutrition policy globally<sup>(26)</sup> and directing more attention towards this age group has been identified as a priority<sup>(27)</sup>.

### Why target the school-setting?

Adolescents spend a significant proportion of their time in school (approximately 40% of their week-day)<sup>(28)</sup>, hence, the school-setting is an important environment in influencing adolescent health. Given that, outside of the home, adolescents spend the majority of their time in school<sup>(29)</sup>, and can consume up to one-half of their daily energy intakes during school hours<sup>(30,31)</sup>, this setting provides a unique opportunity to promote healthy dietary behaviours during this life stage which can be sustained into adulthood<sup>(29)</sup>, and thus, schools are an important setting for intervention delivery<sup>(5)</sup>. School-based interventions have shown promising effects on dietary outcomes, with an increased consumption of fruit and vegetables and reductions in saturated fat and sugar intakes evident among adolescents<sup>(32)</sup>. Moreover, consuming nutritious foods in school has the potential to positively impact academic performance<sup>(33)</sup>. School-based interventions are also advantageous in that they have the ability to target the whole adolescent population simultaneously<sup>(34)</sup>, regardless of socio-economic background<sup>(35)</sup>. Thus, schools provide an additional opportunity to access and intervene with adolescents from socially deprived areas who are reported to consume less nutritious diets<sup>(17,18)</sup>, which can aid in targeting a reduction of health inequalities among this population<sup>(36)</sup>. By addressing the whole population, stigmatisation among adolescents' weight status can also be minimised. Despite the many benefits of this setting, the most effective ways to utilise schools as a means to encourage healthful dietary behaviours among adolescents has yet to be fully identified and there is a lack of consensus on exactly which school strategies have the greatest potential for positive dietary change<sup>(37)</sup>. Additionally, an imbalance exists in the lack of robust evidence from post-primary schools, with systematic reviews highlighting a larger number of dietary interventions conducted in primary schools during 1990–2020<sup>(38,39)</sup>, and further research in post-primary schools (targeting the adolescent population) to determine which intervention strategies are most likely to have the greatest impact is highlighted as being warranted<sup>(39)</sup>.

### The school-setting

School food practices vary widely across different countries<sup>(40)</sup>. However, in the UK, adolescents typically



purchase food in school canteens, bring a packed lunch or purchase food from external food environments. Packed lunches<sup>(41–44)</sup> and foods from external outlets<sup>(43,45)</sup> have been associated with less favourable nutritional profiles than meals purchased in post-primary schools (school meals). There is also a lack of existing regulation for packed lunches<sup>(45)</sup>. Therefore, measures to improve the uptake of school meals among adolescents could prove beneficial in achieving healthier dietary intakes among this population. In Northern Ireland (NI), the complexity of the post-primary school food environment in comparison to primary school settings has been highlighted<sup>(46)</sup>. The majority of post-primary schools in NI offer self-service lunch systems, with a variety of food options available as opposed to a set daily menu in primary school<sup>(46)</sup>, and thus, adolescents become responsible for making their own independent dietary choices on a daily basis. In an effort to increase and promote nutritious options at lunch time in school, school food standards have been implemented in many countries, including the UK. Although similarities exist in these school-based standards, they vary across each UK region<sup>(47)</sup>. In relation to NI, food-based standards were implemented across post-primary schools in 2007<sup>(48)</sup>, which aimed to provide healthier options for adolescents to purchase. However, there is no guarantee that pupils will choose these<sup>(49,50)</sup>, and it is therefore essential that additional motivators for and barriers to healthful food choices within this setting are considered.

### **Impact of nutritional knowledge on adolescents' dietary choices**

When determining how best to improve adolescents' dietary choices within the school-setting, it is important to consider their level of nutritional knowledge and whether they are aware of the healthier food items available to them and their associated health benefits. Both early and more current research indicates that adolescents across several countries possess a good level of nutritional knowledge<sup>(7,51–55)</sup> and have awareness on both the short- and long-term consequences to their health of not consuming a nutritious diet<sup>(7,52,54)</sup>. However, it has been highlighted that this level of nutritional knowledge does not always translate into their behaviours and actual choice of food<sup>(54,56)</sup> and nutrition is often not a primary consideration when making their dietary decisions<sup>(51,57,58)</sup>, with other competing factors which can grant more instant gratification, such as taste, appearance, price and convenience often taking priority<sup>(6,51,58)</sup>. For example, among US adolescents, taste, hunger and convenience were reported as more influential on their dietary choices than the perceived health benefits of foods<sup>(6)</sup>. Similarly, in a study with Australian adolescents, food appeal and price were reported to take precedence over the healthiness of the items when purchasing foods in schools<sup>(58)</sup>. Moreover, evidence suggests that adolescents' have a low-risk perception of the consequences of consuming an unhealthy diet during their life stage<sup>(6,7,32,51,52,59)</sup>, and thus, view consuming a

healthy diet more important in the future<sup>(6)</sup>, when health is considered of more relevance<sup>(55)</sup>. A study in the Netherlands reported that adolescents felt that it is unnecessary to change their dietary behaviours unless their diet affected their appearance, for example, caused weight gain or impacted negatively on their sports performance<sup>(52)</sup>. In NI and Ireland, adolescents reported that they would consider eating a healthier diet if they suffered serious health consequences, for example, became overweight or obese<sup>(51)</sup>. A further consideration is that, despite adolescents' having good nutritional knowledge, many adolescents categorise foods as 'healthy' or 'unhealthy'<sup>(49,52)</sup>, which overlooks the concept of a balanced diet. In contrast to nutritional knowledge, although environmental food cues, such as the visibility of food items, food accessibility, smell and the dining environment, can significantly impact dietary choices, evidence suggests adolescents' recognition of these influences is limited<sup>(60)</sup>.

### **Factors influencing adolescents' school-based dietary choices**

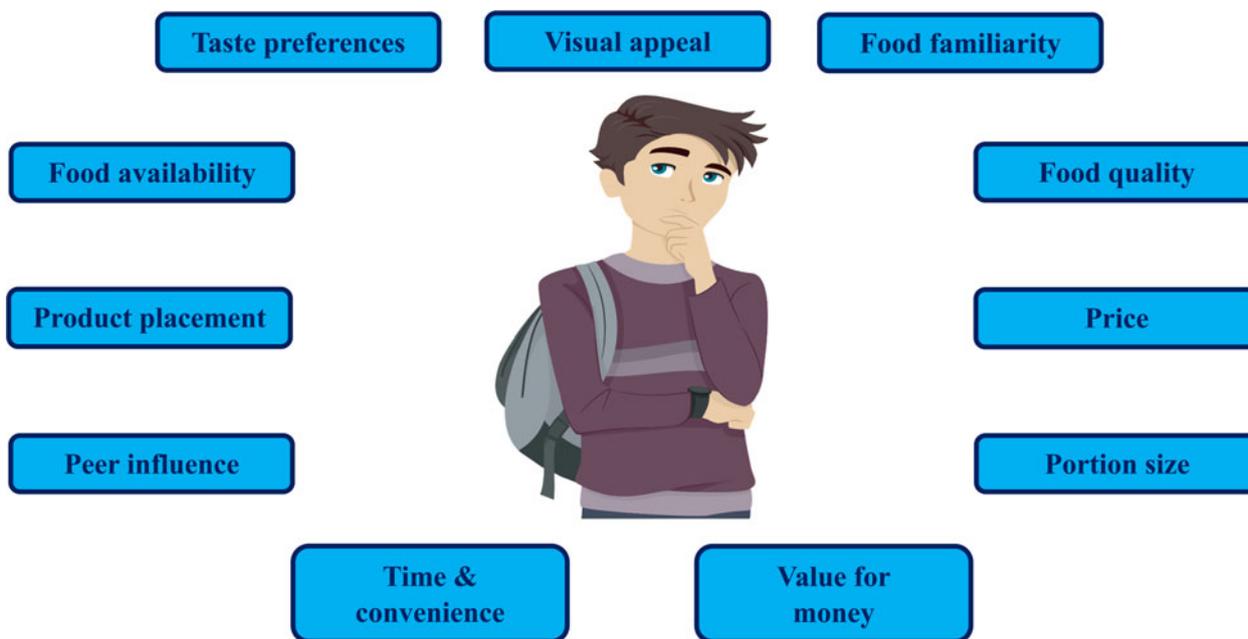
As nutritional knowledge does not appear to be a primary consideration among adolescents, it is important to examine what alternate factors may be influencing their food choices and decisions in school and if any barriers exist to selecting the healthier items available. Gaining an understanding of these factors can aid in the development of effective interventions<sup>(61)</sup>.

The complexity of the influential factors on adolescents' dietary behaviours has been acknowledged<sup>(62)</sup>, and thus, to aid understanding, the factors can be categorised under four different levels of influence including individual (intrapersonal), social environmental (interpersonal), physical environmental and macro environment<sup>(62)</sup>. Numerous influential factors on adolescents' dietary choices in school have been identified in the literature; however, those commonly reported include individual (taste preferences, visual appeal, familiarity, food quality, price, portion size, value for money, time and convenience), social environmental (peer influence), physical environmental (product placement) and macro environment (food availability) level factors as summarised in Fig. 1. These influential factors will be briefly discussed in turn next.

#### **Individual (intrapersonal)**

##### *Taste preferences, visual appeal, familiarity and food quality*

Taste preferences have been reported as influential in shaping adolescents' dietary choices<sup>(51,63,64)</sup>, which can act as a deterrent to selecting a healthier option<sup>(64)</sup>. The recent UNICEF global Food and Me report<sup>(64)</sup> identified that, among 656 adolescents across eighteen countries, perceived taste of healthy foods acted as the second greatest barrier to their consumption of these foods. The influence of taste on adolescents' food choices is also reflected within the school-setting, with adolescents'



**Fig. 1.** Factors influencing adolescents' dietary choices in the school-setting.  
Source of image: BNP Design Studio/Shutterstock.com.

taste preferences being identified as an important consideration when making dietary decisions in school<sup>(49,65–68)</sup>. For example, in a US study, the majority of adolescents (93.7%) reported taste as important when they were selecting food items in the school canteen<sup>(65)</sup>. Similarly, in a UK study, taste was reported as a priority among adolescents<sup>(69)</sup>. Therefore, this may create challenges to encouraging adolescents to choose healthier items in school, as research suggests that adolescents tend to associate healthier options with being of poorer taste<sup>(54,69,70)</sup>. UK school catering staff have also shared the view that adolescents are seen to opt for the less healthy items and have expressed concerns that excluding these unhealthy foods from the school lunch menu would severely compromise their sales<sup>(71)</sup>. Therefore, if not offered on menus, adolescents may choose to bring a packed lunch as an alternative to buying food in school<sup>(71)</sup>, negatively impacting on the financial viability of school canteens. Moreover, UK adolescents and caterers suggested that if healthy items in school tasted better, they would be more appealing to purchase<sup>(69)</sup>. However, caterers felt that to provide school meals that appealed to adolescents, compromising the healthiness of the meals would be required<sup>(69)</sup>. In addition to taste, visual appeal<sup>(49,69,72,73)</sup>, familiarity<sup>(59,66,73)</sup> and quality<sup>(67)</sup> of items served within school have been cited as influential factors on adolescents' food choices. Moreover, dissatisfaction with the quality of school food has also been reported to encourage Scottish adolescents to leave the school premises and source food externally<sup>(74)</sup>.

#### *Price, portion size and value for money*

In the UNICEF global Food and Me report<sup>(64)</sup>, price was reported as the greatest barrier to adolescents

consuming a healthy diet, with financial concerns evident among adolescents in low-, middle- and high-income countries. Research suggests that adolescents also tend to be financially cautious when selecting food and beverage items in school, with price being commonly reported as a key determinant in their purchasing decisions<sup>(49,58,69,71,75)</sup>. Adolescents often perceive the healthier options in school as more expensive than the less healthy options<sup>(49,52,53,58,69)</sup>, which is reported to discourage the purchase of the healthier items in this environment<sup>(53,58,69)</sup>. In the UK, adolescents reported the less healthy items served in school as cheaper, and thus, more tempting and noted that they are more likely to opt for a fizzy drink as opposed to bottled water as it is less expensive<sup>(53)</sup>. The recent UNICEF global Food and Me report<sup>(64)</sup> recommended that '*healthy options need to be available at a price that adolescents see as affordable and competitive with unhealthy food choices*', which appears to also be applicable to the school-setting to aid in encouraging the uptake of healthier items. The perceived expense of food and beverages in school can also act as a barrier to the purchase of school meals, encouraging adolescents to opt for cheaper alternatives<sup>(52,55,71)</sup> or skip their school meal<sup>(75)</sup>. For example, Dutch adolescents have reported preference to purchase foods from external supermarkets as they perceived them to be cheaper than their school canteens<sup>(52)</sup>, whereas, UK adolescents have reported opting for a packed lunch as they are viewed to be less expensive<sup>(55)</sup>. Moreover, Malaysian adolescents have reported skipping their school meals due to limited money availability<sup>(75)</sup>. In addition to price, adolescents' consider portion size<sup>(49,73)</sup> and value for money<sup>(49,65,72,76)</sup> when making choices on food in school, with preference to opt for foods with higher satiety<sup>(49,70,76)</sup>. In NI, adolescents

associated healthier options in school with poor value for money as they perceived them to be more expensive, with lower satiety value<sup>(49)</sup>, which is similar to a study in Malaysia, where school principals' and catering staff noted that adolescents would opt for the most filling items regardless of their nutritional value<sup>(70)</sup>.

#### *Time and convenience*

The limited time often available during lunchtime is a concern for UK adolescents, with adolescents choosing to consume food quickly to enable them to utilise any additional time to socialise with peers, play sports and attend lunchtime activities<sup>(69,77)</sup>. These competing factors have been reported to take priority<sup>(77)</sup>, and consuming a meal at lunchtime being viewed as a 'secondary activity'<sup>(69)</sup>. Additionally, evidence suggests that adolescents also make their dietary choices in the school canteen based on the shortest queue<sup>(55,77)</sup>, which can restrict their food choices<sup>(77)</sup>, and in some cases, research indicates that male adolescents prioritise spending time with their friends as opposed to queuing in the canteen at lunchtime<sup>(49)</sup>. Long queues in the school canteen also act as a barrier to the selection of healthier options<sup>(76)</sup> and the consumption of school meals<sup>(55)</sup>, and instead encourages adolescents to source items from external food outlets<sup>(66)</sup> or purchase items at break time to avoid queuing at lunchtime<sup>(59,66)</sup>. Adolescents also tend to favour convenient, quick, grab-and-go options when purchasing items in the school canteen<sup>(71,78)</sup>. The importance of time on adolescents' food choices in school has also been reported further afield, with long queues reported as a barrier to school-lunch uptake among US adolescents<sup>(79)</sup>.

#### **Social environmental (interpersonal)**

##### *Peer influence*

During adolescence, when time spent with peers increases and parental control tends to diminish<sup>(62,80)</sup>, individuals' dietary behaviours can become influenced by their peers<sup>(81,82)</sup>, often impacting negatively on their food choices, with increased consumption of energy-dense foods of a poor nutritional value<sup>(83)</sup>. The influence of peers on adolescents' food choices is also echoed in research within the school-setting, with school staff<sup>(71,72,84)</sup>, parents<sup>(84)</sup> and adolescents<sup>(49,54,55,57,73,75,78)</sup> reporting peers to be influential on adolescents' school-based dietary choices. When making dietary decisions in school, many adolescents place importance on social acceptability and conforming to what is considered normal eating behaviours among their peers<sup>(49,54,57,73,78)</sup>. This desire for peer acceptance can often impact negatively on adolescents' school-based food choices<sup>(49,54)</sup>. For example, UK adolescents reported their male peers as a direct barrier to consuming a healthier diet in school, indicating that they would opt for the healthier options; however, in doing so, they were at risk of judgement, teasing and social exclusion from their male counterparts which deterred them from purchasing these options<sup>(54)</sup>.

The need for peer acceptance can create challenges to promoting a healthy diet in school, as adolescents may be reluctant to opt for healthier items if this does not align with their peer's food norms<sup>(77)</sup>. Reframing adolescents' views on the acceptability of healthy eating may potentially aid in the promotion of healthier dietary choices among this population<sup>(54)</sup>. However, conversely, in a US study, only two out of thirty-five adolescent participants referred to peers as an influential factor on their food choices within the school-setting, with other food-related factors such as taste, quality and freshness dominating their choice preferences within this environment<sup>(68)</sup>. Albeit, research suggests that peers may influence adolescents indirectly, as adolescents may have a lack of awareness of the impact of social influences on their diet or due to their increase in autonomy, adolescents can be averse to the concept of others influencing their behaviours<sup>(62)</sup>.

#### **Physical environmental**

##### *Product placement*

Placement and positioning of food and beverage items in the school canteen has been reported as an influential factor on adolescents' dietary choices<sup>(49,53,54,67)</sup>. Studies with UK adolescents have described the situation of healthier options available in their school to be less visible and accessible in comparison to the unhealthy items<sup>(49,53,54)</sup>, acting as a barrier to encouraging healthy dietary choices in this setting<sup>(49,54)</sup>. For example, the healthier items have been reported to be placed at the back of fridges<sup>(54)</sup> or having to stand in a separate queue to source them<sup>(49)</sup>. Similarly, US adolescents have reported unhealthy items to be more prominently displayed in school, making it challenging to make improved food choices at lunchtime<sup>(67)</sup>.

#### **Macro environment**

##### *Food availability*

Although school food standards have been implemented in many countries to increase accessibility to healthy food and beverages, high exposure to unhealthy items and limited availability of healthier alternatives in school has been reported across numerous countries<sup>(53,54,58,64,67,70,75,76,85)</sup>, acting as a barrier to healthier eating practices within the school environment<sup>(63,64)</sup>. Adolescents have shared the view that there is insufficient availability of healthier options provided in school<sup>(53,54,67,70)</sup>. In the UK, adolescents have reported feeling they have a lack of choice when selecting foods in school due to the limited availability of healthy items<sup>(54)</sup> and have criticised post-primary schools for offering more unhealthy options in comparison to primary schools<sup>(53)</sup>. Similarly, in Malaysia, adolescents reported temptation for the less healthy items in school due to their large availability and ease of accessibility<sup>(75)</sup>. Adolescents have further reported that they view their schools to be providing conflicting messages in regards



to healthy eating, as they perceive the food canteen menus are in contrast to the healthy eating promotional messages they receive in school<sup>(58)</sup> and what they are being taught from an education point-of-view in the school curriculum<sup>(57,85)</sup>.

In addition to these factors influencing adolescents' dietary choices in school and providing insight into some of the challenges adolescents face in selecting the healthier options in this setting, some of these factors can also act as barriers to consuming school meals and stimulate adolescents to opt for a packed lunch or source food from external outlets. This may ultimately lead to school canteens becoming non-financially viable and result in canteen closures, reducing opportunities for researchers and policy makers to access and intervene with this population. Additionally, packed lunches<sup>(41–44)</sup> and food from external outlets<sup>(43,45)</sup> are also often reported to be less healthy lunch sources than school meals. Therefore, by addressing some of these key factors in the school-setting, not only does this provide an opportunity to facilitate improved dietary choices in school, but also potentially increase the uptake of school meals. It must be acknowledged that the majority of included studies are primarily of qualitative methodologies, with several noting the inability to generalise their findings to other adolescent populations as a study limitation<sup>(49,59,67,69–71,77–79,85)</sup>. Furthermore, to the authors' knowledge, there is currently a lack of robust evidence exploring the barriers and facilitators to adolescents' food choices specifically within the school-setting, that are not grouped with other food environments.

### Recommendations to improve adolescents' school-based dietary choices

Whilst some studies exploring stakeholder's perspectives on the factors influencing adolescents' dietary choices in the school-setting are evident, less is known on what strategies key stakeholder's, for example, adolescents' and school staff (principals, teachers, caterers), would recommend for implementation in schools to aid in improving adolescents' dietary behaviours within this environment. This can be useful information when designing future school-based interventions, as it increases understanding of the most appropriate school strategies adolescents' may be most likely to engage with, whilst also taking into consideration the feasibility of this to schools, ultimately leading to long-term sustainability with regards to time and financial resources involved for schools.

Despite research suggesting that adolescents' have a lack of concern towards healthy eating during their life stage<sup>(6,7,51)</sup>, adolescents across several countries have reported receiving insufficient nutritional education as part of their school curriculum, and thus, have advocated for improvements to be made<sup>(64)</sup>. Recommendations included receiving more adolescent-specific nutritional information and increased opportunities to learn, for example, practical cooking skills as opposed to theory-based learning<sup>(64)</sup>. Moreover, much of the nutritional

information taught in post-primary schools is within a few academic subjects, which not all adolescents choose to study. Contrastingly, in Ireland, although school staff were supportive of further nutrition education being provided to students, adolescents were less favourable of this concept, reporting that they receive sufficient nutrition education and instead expressed views that attention should be directed towards improving the school-food environment<sup>(57)</sup>.

To facilitate improvements in adolescents' dietary behaviours, suggestions have been made to increase the availability of healthier items<sup>(54,64,70,85,86)</sup> and reduce or eliminate the less healthy options<sup>(49,59,64,70,85)</sup> served in school. Although adolescents have criticised the low level of healthy<sup>(53,54,67,70)</sup> and high level of less healthy<sup>(53)</sup> items provided in post-primary schools, and would welcome greater availability of healthy alternatives<sup>(54)</sup>, they also place importance on their own autonomy and value being able to preserve their own freedom of choice in school<sup>(32,78)</sup>, and thus, can be opposed to the concept of banning all unhealthy foods which would stimulate them to source food elsewhere<sup>(59)</sup>. For example, UK adolescents have noted that removing the less healthy options in school would encourage them to purchase items from external competitors or opt for packed lunches and suggested that limiting the availability of the less healthy items to one to two times a week, may be a more feasible strategy as opposed to complete exclusion<sup>(59)</sup>. Similarly, UK school staff have reported that the removal of unhealthy items would impact negatively on their sales<sup>(71)</sup> and have further commented that they recognise the importance of serving healthy school meals, yet they associated the healthier items with financial implications, such as reduced student uptake, less profits and increased wastage<sup>(69)</sup>. Gilmour *et al.*<sup>(71)</sup> have suggested that a slow and guided transition to removing the less healthy items in the canteen may be possible with support at the governmental level.

Several suggestions to improve adolescents' dietary choices within the school-setting in the UK have been reported. Adolescents<sup>(73)</sup> and school staff<sup>(72)</sup> in NI have proposed incentives as a potential strategy to encourage the selection of healthier items served in the school canteen, with both stakeholder groups recommending recognition, social and financial rewards as suitable incentives for this population. Similarly, adolescents' from socially disadvantaged areas across NI have reported reward schemes as an acceptable approach to improve food choices in school, with adolescents' from rural schools favouring group rewards such as class trips and adolescents' from urban schools having preference for individual-type rewards such as vouchers and clothes<sup>(49)</sup>. Other initiatives have focused on improvements to the school food environment where adolescents have, for example, advocated for school's to display menus and pricing information in the canteen, amend product placement so healthier items are displayed more prominently and implement labelling schemes, both at the point-of-choice and on school menus<sup>(73)</sup>. Additional reported suggestions of improvements in school canteens to support healthy food choices include the facility to



pre-order food<sup>(73)</sup>, promotion of ‘special offers’ for the food items deemed to be ‘healthier’<sup>(73)</sup>, improved marketing<sup>(49)</sup>, school staff encouragement to eat healthily<sup>(49)</sup> and the ability to taste healthy foods before purchasing<sup>(49)</sup>. Other suggestions included the ability to offer a ‘meal deal’, increased variety on menus, improvements to school-food (quality and food offered), the promotion of the healthier options and student-led initiatives to facilitate improved dietary choices in school<sup>(72)</sup>.

### Effectiveness of school-based dietary interventions in adolescents

In addition to reviewing the factors that influence adolescents’ food choices within the school-setting and the recommendations for improvements, it is also important to consider the success of school-based intervention studies. Despite an increasing number of dietary interventions being implemented in schools, the most effective school-based interventions to improve adolescents’ dietary behaviours are yet to be determined and evidence remains limited<sup>(39)</sup>. Identifying intervention components that show most promise in the school-setting would facilitate larger scale interventions to be piloted and trialled<sup>(28)</sup>. A range of school-based interventions including the ‘Health promoting schools’ (HPS) initiative, educational, multicomponent, food environment and peer-led, have been conducted to date and their effectiveness are described briefly next (see also Fig. 2). Promising intervention components and study limitations are also highlighted, which should be considered in future research and intervention design.

#### *Health-promoting schools approach*

A HPS is defined by the WHO as a school that ‘*constantly strengthens its capacity as a healthy setting for living, learning and working*’<sup>(87)</sup>. The HPS framework was developed in the 1980s<sup>(88)</sup> and recognises the intrinsic link between education and health<sup>(89)</sup>. This framework advocates for a ‘whole-school’ approach to improve adolescent education and well-being<sup>(90)</sup>, and involves health promotion via the school curriculum, adjusting the school’s social or physical environment, which can include the school canteen, and increased family and community engagement on the topic of health<sup>(91)</sup>. The HPS concept has been positively received and implemented in many countries<sup>(36)</sup> and the WHO has encouraged schools worldwide to adopt this approach<sup>(90)</sup>.

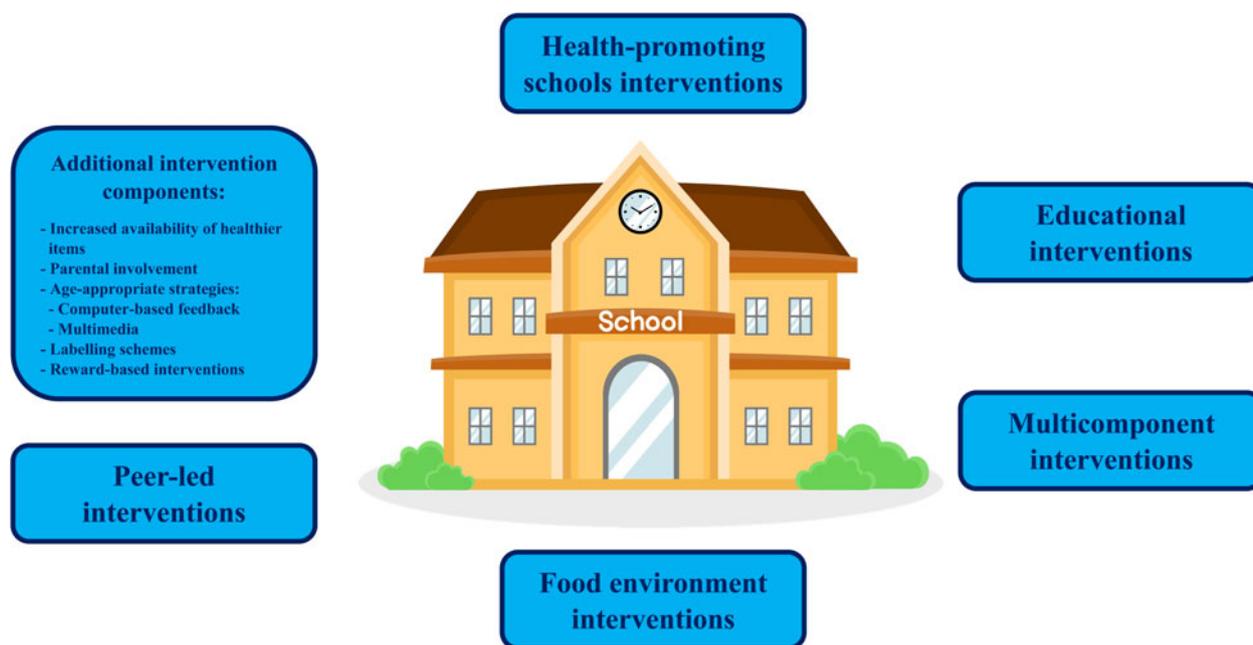
A systematic review (SR)<sup>(36)</sup> exploring the impact of the HPS framework on improving health and educational outcomes in pupils in primary and post-primary schools (aged 4–18 years), reported that nutrition interventions following the HPS framework showed positive effects on increasing fruit and vegetable consumption, with an average increase of 30g daily, albeit, were ineffective in reducing fat intakes. However, the majority of studies in this review targeted children (<12 years), with a lack of nutritional interventions conducted among the adolescent population and this review did

not report on adolescents in isolation<sup>(36)</sup>. A more recent SR<sup>(92)</sup> examined the effectiveness of interventions utilising the HPS framework in promoting physical activity and a healthful diet among adolescents (11–18 years) independently and reported no effect of HPS nutrition-only interventions on adolescents’ fruit and vegetable intakes. Four nutrition-specific interventions were included in this review, with two studies<sup>(93,94)</sup> reporting minor positive outcomes. For example, Hoppu *et al.*<sup>(94)</sup> showed that the incorporation of HPS components resulted in a reduction in the percentage of energy intake from sucrose (decreasing 2.3%) and the consumption of sweets among adolescents in the intervention. However, this intervention study only targeted pupils in the eighth grade (average 13.8 years at baseline), and thus, results may not be applicable to all adolescents<sup>(94)</sup>. However, overall this SR<sup>(92)</sup> concluded that HPS nutrition interventions had limited impact on improving adolescents’ dietary behaviours. It must be noted that in this review<sup>(92)</sup>, heterogeneity was evident among the study designs, nutrition HPS-based interventions were rated as low quality and studies were lacking among the adolescent population, including adolescents aged 11–15 years, with no studies being conducted with the older adolescent age group (16–18 years).

#### *Educational vs multicomponent interventions*

Other intervention studies have solely focused on school-based educational approaches when aiming to improve adolescents’ dietary behaviours. However, educational interventions are reliant on making deliberate dietary decisions which doesn’t take into consideration the automatic nature of making food choices<sup>(95)</sup>. An earlier SR<sup>(38)</sup>, exploring European studies among adolescents (aged 13–18 years) reported moderate evidence of effect of educational interventions on promoting a healthful diet among this age group. This review included six education-only interventions targeting adolescents [UK (*n* 3); Belgium (*n* 1); Norway (*n* 1); the Netherlands (*n* 1)] and were published during 1993–2008, of which the majority of interventions utilised activities in the classroom, for example, amendments to the curriculum and providing education-based materials<sup>(38)</sup>.

More recent evidence suggests that school-based multicomponent interventions may be more effective than education-only interventions in achieving positive dietary change among the adolescent population, with a recent SR of systematic reviews<sup>(39)</sup>, which included three systematic reviews on educational interventions and dietary behaviours in adolescents, reporting success among education-based studies if specific components were also incorporated into the interventions. For example, Meiklejohn *et al.*<sup>(96)</sup> explored the effect of multi-strategy educational interventions (combination of nutrition education with additional strategies) on adolescents’ (10–18 years) health and nutritional behaviours. This review included eleven studies from Sweden (*n* 1), Belgium (*n* 1), Finland (*n* 1), Greece (*n* 1), Norway (*n* 2), the Netherlands, Spain and Norway (*n* 1), Australia (*n* 2) and the USA (*n* 2) and reported positive dietary



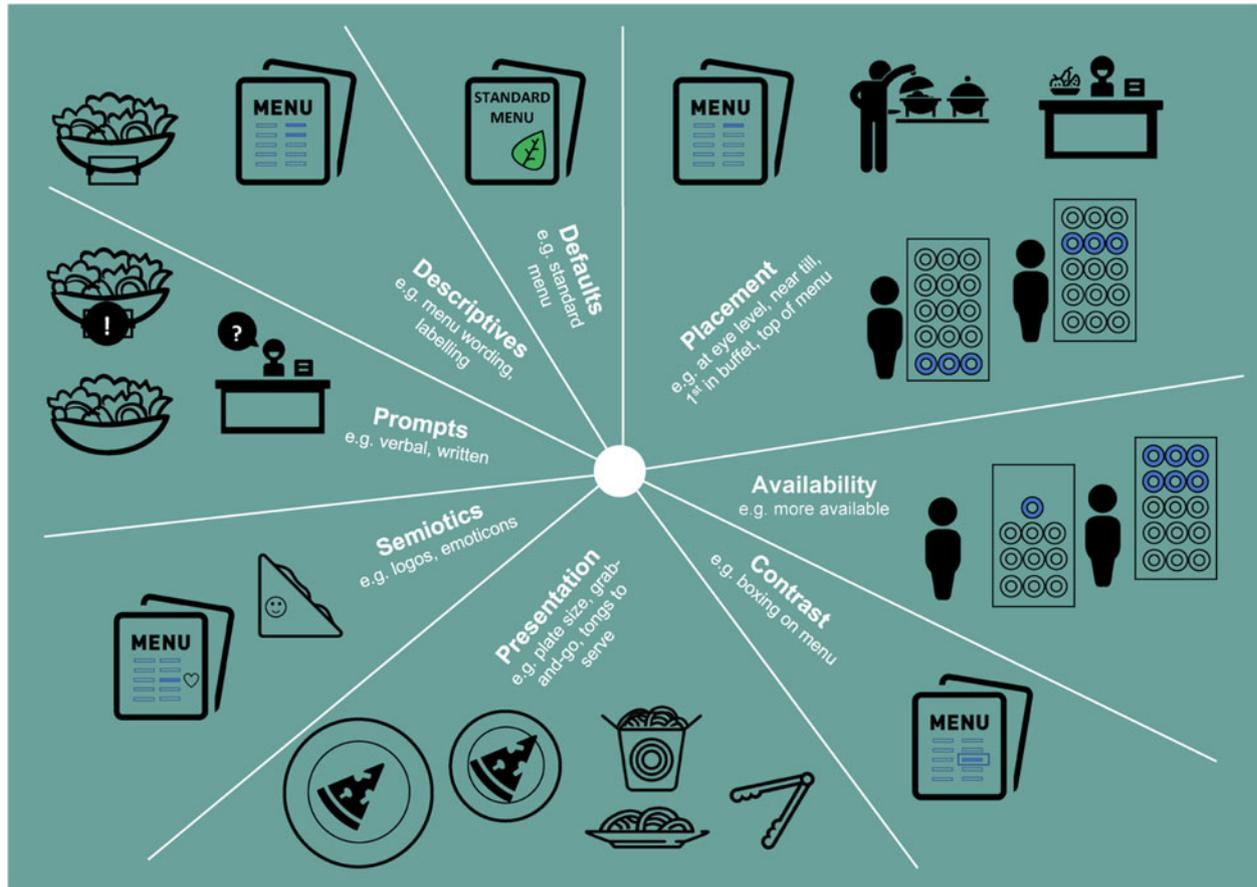
**Fig. 2.** School-based interventions aiming to improve adolescents' school-based dietary behaviours.  
Source of image: Kwang Chanakarn/Shutterstock.com.

outcomes among studies ( $n\ 9$ ) when educational interventions included complementary components, for example, school staff facilitating the intervention, involving parents, amending the food environment in school and if the intervention is guided by theory<sup>(96)</sup>. Additionally, a SR conducted by Murimi *et al.*<sup>(97)</sup> reported that multi-component nutritional education interventions in post-primary schools were more likely to succeed if some intervention characteristics included, for example, engaging with parents and utilising technology. Overall, the SR of systematic reviews<sup>(39)</sup>, reported that, five systematic reviews concluded multicomponent interventions (combination of educational and environmental changes) to be more successful than interventions solely adopting educational approaches.

#### *Food environment interventions*

The school food environment has been proposed as a way of improving food choices in school<sup>(72,73,98)</sup>. The school food environment and the concept of choice architecture, commonly referred to as nudging, behavioural economics or libertarian paternalism<sup>(99)</sup>, is emerging as a promising strategy to modify adolescents' dietary behaviours in the school-setting. Food choice architecture refers to how food choices are framed and how this impacts on food selection<sup>(100)</sup>. It nudges individuals towards particular dietary choices via subtle, low-cost changes to the food environment<sup>(95,101)</sup>. Ultimately it involves making the preferred choice, the easiest choice without eliminating food options, thereby, maintaining freedom of choice<sup>(95)</sup>. Different food choice architecture strategies have been employed in schools to encourage positive food choices which include making amendments to the attractiveness of foods displayed, the visibility of

specific food items and their convenience<sup>(102)</sup>. More specific food choice architecture intervention components are outlined in Fig. 3 and reviewed by Ensaff<sup>(95)</sup>. Food choice architecture interventions have shown promising outcomes for improving adolescents' dietary choices in post-primary schools. For example, the incorporation of complementary food choice architecture components into a UK post-primary school canteen, such as amending product placement, introducing labelling strategies, promotional posters and increasing convenience, resulted in adolescents being 2.5 times more likely to opt for the promoted items (whole fruit, fruit pots, vegetarian specials and salad-based sandwiches) and 7.5 times more likely to opt for salad items specifically during the intervention period when compared to baseline<sup>(100)</sup>. Outcomes in this study were based on sales of food as opposed to consumption data<sup>(100)</sup>. Furthermore, the effect of the intervention components were reported on collectively, and therefore, the impact of each individual component remains unclear and it is difficult to interpret if one change in the choice architecture was more successful than the others<sup>(100)</sup>. More recently, Spence *et al.*<sup>(103)</sup> delivered an intervention in two UK post-primary schools, which focused specifically on amending product placement by increasing the accessibility of healthier (fruit and water) and reducing the accessibility of the less healthy (sweet-baked goods and sugar-sweetened beverage) items in the canteen setting at lunchtime. Spence *et al.*<sup>(103)</sup> reported positive outcomes on pupils' food and beverage purchases in both school A (increase in fruit pot purchases; decrease in sugar-sweetened beverage purchases) and school B (decrease in sweet-baked goods and sugar-sweetened beverage purchases). Overall, the authors concluded that there is some limited evidence that product placement



**Fig. 3.** Choice architecture intervention components.

Source: Fig: 'Nudge strategies implemented in choice architecture interventions to change food choice: reducing effort and cognitive load, increasing salience and emphasising tastiness and social norms.' Ensaif<sup>(95)</sup>.

interventions may positively impact pupils' food and beverage purchasing decisions<sup>(103)</sup>. Additionally, a recent SR<sup>(104)</sup> aimed to assess the effectiveness of school nudge interventions on pupils' dietary behaviours in the school canteen. This review included twenty-nine studies from the USA (*n* 26); Australia (*n* 1); France (*n* 1) and the UK (*n* 1) and nudge interventions were categorised as: marketing/ promotion; placement/ convenience; variety/ portion sizes; multicomponent (studies with >1 intervention component)<sup>(104)</sup>. This review<sup>(104)</sup> reported a positive association between school nudge interventions and pupils' food selection; however, conclusions are based on studies conducted across both primary and post-primary schools. Another SR<sup>(105)</sup> examined the effectiveness of choice architecture nudge interventions on promoting vegetable intake among adolescents specifically in school. This review included twelve studies [USA (*n* 9); Canada (*n* 2); Europe (*n* 1)], with interventions to promote vegetable intake among adolescents including amendments to the serving style and physical environment and free vegetable distribution, however, findings were inconclusive<sup>(105)</sup>. Heterogeneity was noted across the studies intervention type and outcome measures, the majority of studies were reported as low or moderate quality and vegetables did not appear to be a primary focus among interventions<sup>(105)</sup>. This SR<sup>(105)</sup> also

highlighted that none of the included studies explored adolescents' attitudes towards the choice architecture nudge interventions, limiting understanding of adolescents' acceptability towards these types of school strategies. Given the potential nudge-based interventions offer in facilitating improved dietary practices within schools, a recent WHO policy brief<sup>(101)</sup> aimed to raise awareness of the opportunities in which nudge strategies could be implemented within the school-setting, for example, in the school canteen, food vending machines and tuck shops. This policy brief<sup>(101)</sup> also outlines the rationale and evidence for school-based nudge strategies and provides a step-by-step guide for developing and implementing nudges within the school environment<sup>(101)</sup>. Although nudge-based interventions in the school-setting show promise, this policy brief<sup>(101)</sup> also highlights their associated challenges and limitations, reporting that mixed findings are evident, and more research is needed to determine their long-term effects. Moreover, there is limited evidence among low- and middle-income countries, with the majority of studies to date being conducted in Europe and the USA<sup>(101)</sup>. Variation between schools should also be considered, with the WHO policy brief outlining 'proposed nudges should be developed, as appropriate, to the specific context; that is, one size does not fit all and actions will vary between individual schools'<sup>(101)</sup>.

### Peer-led interventions

Peer-led, school-based nutrition initiatives have the potential to improve dietary attitudes, knowledge and self-efficacy<sup>(106)</sup>, and therefore, peer-led interventions in school are also receiving increasing attention as an effective means to promote improved dietary behaviours among adolescents. It has been suggested that when targeting adolescents' dietary behaviours, adolescent-led interventions may increase effectiveness as they may be more aware of this population's values<sup>(107)</sup>. Peer involvement has been reported as an important contributing factor to the success of school-based dietary interventions among adolescents and should be considered in future intervention design<sup>(19,39)</sup>. For example, in a SR<sup>(19)</sup> examining the effectiveness of in-school interventions aiming to improve adolescents (11–16 years) dietary behaviours, nine studies included peer involvement, all of which were successful in promoting positive dietary change among this age group, with the majority of these studies ( $n = 5$ ) receiving a quality rating of moderate to strong. Similarly, Foley *et al.*<sup>(80)</sup> also reported that peer-led interventions in school can also promote improved dietary intakes among peer-leaders (15–16 years) involved in the delivery of the intervention to younger students in their school (13–14 years). Involvement in this study also appeared to be highly acceptable to participating peer-leaders, as following completion of the study, when asked if they would recommend the intervention programme to others, 91% of those involved reported that they would<sup>(80)</sup>. The authors have recently completed a peer-led, school-based pilot feasibility study in NI aiming to promote healthy dietary choices among adolescents (11–12 years). Further details on the pilot study is outlined on the Generating Excellent Nutrition in UK Schools website<sup>(108)</sup>.

### Additional intervention components

A recent SR of systematic reviews ( $n = 13$ )<sup>(39)</sup> on dietary interventions among adolescents (11–18 years) in post-primary schools identified several promising intervention components that are worth consideration in future interventions aiming to improve dietary behaviours among adolescents in school. In addition to peer involvement and multicomponent interventions, this SR<sup>(39)</sup> recommended utilising approaches such as increasing the availability of healthier items in school, involvement from parents and incorporating 'age-appropriate' strategies, for example, computer-based feedback and multimedia to aid in potentially improving the success of future dietary interventions targeted at this population. This SR<sup>(39)</sup> also highlighted that the majority of included systematic reviews received a 'low' ( $n = 7$ ) and 'critically low' ( $n = 3$ ) quality rating, therefore, Capper *et al.* cautioned interpretation of these findings. Another SR<sup>(109)</sup> examined the effectiveness of menu labelling in the school canteen to aid with adolescents' dietary choices and showed positive results in two out of three studies. Conklin *et al.*<sup>(110)</sup> reported that nutritional labels placed at the

point-of-selection in the school canteen resulted in adolescents opting for items with lower energy and fat content. Similarly, Hunsberger *et al.*<sup>(111)</sup> reported that displaying energy labels at the point-of-purchase resulted in an average energy decrease of 47 calories and 2.1g of total fat among adolescents (11–15 years). Although these studies<sup>(110,111)</sup> reported positively influencing adolescents food choices in the school canteen, both studies were conducted within the USA and Sacco *et al.*<sup>(109)</sup> acknowledged their methodological limitations and classified these studies of 'weak' quality. Researchers in the UK have considered a variety of different ways to improve adolescents' dietary choices within the school-setting. In NI, Rooney *et al.*<sup>(112)</sup> reported high acceptability of a rewards-based intervention to encourage healthier food choices among adolescents (12–14 years) in school canteens. Similarly, Devine *et al.* undertook qualitative interviews<sup>(72)</sup> and focus groups<sup>(73)</sup> with school staff and adolescents respectively, in which initiating student-led initiatives<sup>(72)</sup> and providing incentives<sup>(72,73)</sup> were some examples of appropriate strategies suggested to facilitate adolescents' making improved dietary decisions within the school canteen. These qualitative findings<sup>(72,73)</sup>, informed the design and delivery of a peer-led, school-based pilot feasibility study<sup>(108)</sup> which included incentives, for example, social and financial rewards, as one of the study components to encourage the selection of healthier items served in the school canteen.

### Conclusions

There is an urgent need to improve nutritional intakes among the adolescent population to aid in achieving better health outcomes. Adolescence presents a key time to intervene when individuals are developing a greater sense of autonomy and exercising increased independence when making their dietary choices as they transition towards adulthood and schools therefore provide an ideal setting to access and promote positive dietary behaviours among this particularly vulnerable group within a controlled environment. Adolescents' dietary behaviours within the school-setting are complex and multifactorial. Therefore, gaining a holistic view by identifying the main factors and barriers which influence adolescents' food choices in school is important for researchers and policy makers to consider as they approach the design of future interventions. Whilst evidence is available on the factors influencing adolescents' dietary choices, more research on adolescents' and school staff's suggestions on how best to address these barriers using school-based strategies in the development of future interventions would be worthwhile. Moreover, to build on the current evidence and aid in establishing best practice in schools, future research should direct attention to the intervention components which show most promise and address the current methodological limitations and research gaps present in school-based dietary interventions. Ultimately, generating an evidence-base with which to inform and enhance the development of future successful

school-based interventions will help ensure such interventions are feasible, tailored to the target population and optimise outcomes.

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### Conflict of Interest

None.

### Authorship

L. D. D. drafted the manuscript. A. J. H. and A. M. G. critically revised the manuscript for important intellectual content. All authors have read and approved the final manuscript.

### References

1. WHO (2022) Adolescent health. [https://www.who.int/health-topics/adolescent-health#tab=tab\\_1](https://www.who.int/health-topics/adolescent-health#tab=tab_1) (accessed July 2022).
2. Patton GC, Sawyer SM, Santelli JS *et al.* (2016) Our future: a Lancet Commission on adolescent health and wellbeing. *Lancet* **387**, 2423–2478.
3. Wu XY, Zhuang LH, Li W *et al.* (2019) The influence of diet quality and dietary behaviour on health-related quality of life in the general population of children and adolescents: a systematic review and meta-analysis. *Qual Life Res* **28**, 1989–2015.
4. Aljaraedah TY, Takruri HR & Tayyem RF (2019) Dietary practices and nutrient intake among adolescents: a general review. *Obes Med* **16**, 100145.
5. Hargreaves D, Mates E, Menon P *et al.* (2022) Strategies and interventions for healthy adolescent growth, nutrition, and development. *Lancet* **399**, 198–210.
6. Neumark-Sztainer D, Story M, Perry C *et al.* (1999) Factors influencing food choices of adolescents: findings from focus-group discussions with adolescents. *J Am Diet Assoc* **99**, 929–937.
7. Croll JK, Neumark-Sztainer D & Story M (2001) Healthy eating: what does it mean to adolescents? *J Nutr Educ* **33**, 193–198.
8. Lytle LA & Kubik MY (2003) Nutritional issues for adolescents. *J Am Diet Assoc* **102**, S8–S12.
9. Neufeld LM, Andrade EB, Suleiman AB *et al.* (2022) Food choice in transition: adolescent autonomy, agency, and the food environment. *Lancet* **399**, 185–197.
10. Lake AA, Mathers JC, Rugg-Gunn AJ *et al.* (2006) Longitudinal change in food habits between adolescence (11–12 years) and adulthood (32–33 years): the ASH30 study. *J Public Health* **28**, 10–16.
11. Craigie AM, Lake AA, Kelly SA *et al.* (2011) Tracking of obesity-related behaviours from childhood to adulthood: a systematic review. *Maturitas* **70**, 266–284.
12. Spear BA (2002) Adolescent growth and development. *J Am Diet Assoc* **102**, S23–S29.
13. Neumark-Sztainer D, French SA, Hannan PJ *et al.* (2005) School lunch and snacking patterns among high school students: associations with school food environment and policies. *Int J Behav Nutr Phys Act* **2**, 14.
14. Rippin HL, Hutchinson J, Jewell J *et al.* (2019) Child and adolescent nutrient intakes from current national dietary surveys of European populations. *Nutr Res Rev* **32**, 38–69.
15. Fitzgerald A, Heary C, Nixon E *et al.* (2010) Factors influencing the food choices of Irish children and adolescents: a qualitative investigation. *Health Promot Int* **25**, 289–298.
16. Lytle LA, Seifert S, Greenstein J *et al.* (2000) How do children's eating patterns and food choices change over time? Results from a cohort study. *Am J Health Promot* **14**, 222–228.
17. Hanson MD & Chen E (2007) Socioeconomic status and health behaviors in adolescence: a review of the literature. *J Behav Med* **30**, 263–285.
18. Utter J, Denny S, Crengle S *et al.* (2011) Socio-economic differences in eating-related attitudes, behaviours and environments of adolescents. *Public Health Nutr* **14**, 629–634.
19. Calvert S, Dempsey RC & Povey R (2019) Delivering in-school interventions to improve dietary behaviours amongst 11- to 16-year-olds: a systematic review. *Obes Rev* **20**, 543–553.
20. Reilly JJ & Kelly J (2011) Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. *Int J Obes* **35**, 891–898.
21. Singh AS, Mulder C, Twisk JW *et al.* (2008) Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obes Rev* **9**, 474–488.
22. Withrow D & Alter DA (2011) The economic burden of obesity worldwide: a systematic review of the direct costs of obesity. *Obes Rev* **12**, 131–141.
23. Van Jaarsveld CH & Gulliford MC (2015) Childhood obesity trends from primary care electronic health records in England between 1994 and 2013: population-based cohort study. *Arch Dis Child* **100**, 214–219.
24. Blake V & Patel K (2015) Treatment of adolescent obesity. *Br J Obes* **1**, 142–147.
25. Fan H & Zhang X (2022) Recent trends in overweight and obesity in adolescents aged 12 to 15 years across 21 countries. *Pediatr Obes* **17**, e12839.
26. Al-Jawaldeh A, Bekele H, de Silva A *et al.* (2022) A new global policy framework for adolescent nutrition? *Lancet* **399**, 125–127.
27. Dick B & Ferguson BJ (2015) Health for the world's adolescents: a second chance in the second decade. *J Adolesc Health* **56**, 3–6.
28. Woodside JV, Adamson A, Spence S *et al.* (2021) Opportunities for intervention and innovation in school food within UK schools. *Public Health Nutr* **24**, 2313–2317.



29. Story M, Nannery MS & Schwartz MB (2009) Schools and obesity prevention: creating school environments and policies to promote healthy eating and physical activity. *Milbank Q* **87**, 71–100.
30. Micha R, Karageorgou D, Bakogianni I *et al.* (2018) Effectiveness of school food environment policies on children's dietary behaviors: a systematic review and meta-analysis. *PLoS ONE* **13**, e0194555.
31. Nathan N, Janssen L, Sutherland R *et al.* (2019) The effectiveness of lunchbox interventions on improving the foods and beverages packed and consumed by children at centre-based care or school: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act* **16**, 1–5.
32. Rose K, O'Malley C, Eskandari F *et al.* (2021) The impact of, and views on, school food intervention and policy in young people aged 11–18 years in Europe: a mixed methods systematic review. *Obes Rev* **22**, e13186.
33. Anderson ML, Gallagher J & Ritchie ER (2018) School meal quality and academic performance. *J Public Econ* **168**, 81–93.
34. Oostindjer M, Aschemann-Witzel J, Wang Q *et al.* (2017) Are school meals a viable and sustainable tool to improve the healthiness and sustainability of children's diet and food consumption? A cross-national comparative perspective. *Crit Rev Food Sci Nutr* **57**, 3942–3958.
35. Vézina-Im LA, Beaulieu D, Bélanger-Gravel A *et al.* (2017) Efficacy of school-based interventions aimed at decreasing sugar-sweetened beverage consumption among adolescents: a systematic review. *Public Health Nutr* **20**, 2416–2431.
36. Langford R, Bonell C, Jones H *et al.* (2015) The World Health Organization's health promoting schools framework: a Cochrane systematic review and meta-analysis. *BMC Public Health* **15**, 130.
37. Chaudhary A, Sudzina F & Mikkelsen BE (2020) Promoting healthy eating among young people – a review of the evidence of the impact of school-based interventions. *Nutrients* **12**, 2894.
38. Van Cauwenbergh E, Maes L, Spittaels H *et al.* (2010) Effectiveness of school-based interventions in Europe to promote healthy nutrition in children and adolescents: systematic review of published and 'grey' literature. *Br J Nutr* **103**, 781–797.
39. Capper TE, Brennan SF, Woodside JV *et al.* (2022) What makes interventions aimed at improving dietary behaviours successful in the secondary school environment? A systematic review of systematic reviews. *Public Health Nutr* **25**, 2448–2464.
40. Harper C, Wood L & Mitchell C (2008) The provision of school food in 18 countries. <https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.16.549.233&rep=rep1&type=pdf> (accessed June 2022).
41. Pearce J, Wood L & Nelson M (2012) Lunchtime food and nutrient intakes of secondary-school pupils; a comparison of school lunches and packed lunches following the introduction of mandatory food-based standards for school lunch. *Public Health Nutr* **16**, 1126–1131.
42. Stevens L, Nicholas J, Wood L *et al.* (2013) School lunches v. packed lunches: a comparison of secondary schools in England following the introduction of compulsory school food standards. *Public Health Nutr* **16**, 1037–1042.
43. Wyness L, Norris C, Clapham M *et al.* (2016) School meal contribution to nutrient intake amongst 11–14 year old Scottish schoolchildren. *EC Nutr* **4**, 836–844.
44. Parnham JC, Chang K, Rauber F *et al.* (2022) The ultra-processed food content of school meals and packed lunches in the United Kingdom. *Nutrients* **14**, 2961.
45. Taher AK, Ensaif H & Evans CE (2020) Cross-sectional associations between lunch-type consumed on a school day and British adolescents' overall diet quality. *Prev Med Rep* **19**, 101133.
46. Capper T, Brennan S, Woodside J *et al.* (2019) The EIT food school network: integrating solutions to improve eating habits and reduce food wastage in secondary school-children. *Nutr Bull* **44**, 356–362.
47. McIntyre RL, Adamson AJ, Nelson M *et al.* (2022) Changes and differences in school food standards (2010–2021) and free school meal provision during COVID-19 across the UK: potential implications for children's diets. *Nutr Bull* **47**, 230–245.
48. Public Health Agency (2010) Nutritional standards for school lunches – a guide for implementation. [https://www.publichealth.hscni.net/sites/default/files/Nutritional%20standards%20for%20school%20lunches%20-%20a%20guide%20for%20implementation%2009\\_10.pdf](https://www.publichealth.hscni.net/sites/default/files/Nutritional%20standards%20for%20school%20lunches%20-%20a%20guide%20for%20implementation%2009_10.pdf) (accessed July 2022).
49. McEvoy CT, Lawton J, Kee F *et al.* (2014) Adolescents' views about a proposed rewards intervention to promote healthy food choice in secondary school canteens. *Health Educ Res* **29**, 799–811.
50. Van Kleef E, Meeuwssen T, Rigterink J *et al.* (2019) Moving towards a healthier assortment in secondary and vocational school food environments: perspectives of Dutch students and school food policy professionals. *Br Food J* **121**, 2052–2066.
51. Stevenson C, Doherty G, Barnett J *et al.* (2007) Adolescents' views of food and eating: identifying barriers to healthy eating. *J Adolesc* **30**, 417–434.
52. Hermans RC, De Bruin H, Larsen JK *et al.* (2017) Adolescents' responses to a school-based prevention program promoting healthy eating at school. *Front Public Health* **5**, 309.
53. McHugh CA, Anderson L, Lloyd J *et al.* (2019) Influences on diet and physical activity choices of 11–13-year-olds in a school setting. *Health Educ J* **78**, 545–556.
54. Calvert S, Dempsey RC & Povey R (2020) A qualitative study investigating food choices and perceived psychosocial influences on eating behaviours in secondary school students. *Br Food J* **122**, 1027–1039.
55. Ryan D, Holmes M & Ensaif H (2022) Adolescents' dietary behaviour: the interplay between home and school food environments. *Appetite* **175**, 106056.
56. Ridder MA, Heuvelmans MA, Visscher TL *et al.* (2010) We are healthy so we can behave unhealthily: a qualitative study of the health behaviour of Dutch lower vocational students. *Health Educ* **110**, 30–42.
57. Browne S, Barron C, Staines A *et al.* (2020) 'We know what we should eat but we don't...': a qualitative study in Irish secondary schools. *Health Promot Int* **35**, 984–993.
58. Ronto R, Carins J, Ball L *et al.* (2019) Adolescents' views on high school food environments. *Health Promot J Austr* **32**, 458–466.
59. McSweeney L, Bradley J, Adamson AJ *et al.* (2019) The 'voice' of key stakeholders in a school food and drink intervention in two secondary schools in NE England: findings from a feasibility study. *Nutrients* **11**, 2746.
60. Ensaif H, Coan S, Sahota P *et al.* (2015) Adolescents' food choice and the place of plant-based foods. *Nutrients* **7**, 4619–4637.
61. Cusatis DC & Shannon BM (1996) Influences on adolescent eating behavior. *J Adolesc Health* **18**, 27–34.
62. Story M, Neumark-Sztainer D & French S (2002) Individual and environmental influences on adolescent eating behaviors. *J Am Diet Assoc* **102**, S40–S51.

63. Shepherd J, Harden A, Rees R *et al.* (2006) Young people and healthy eating: a systematic review of research on barriers and facilitators. *Health Educ Res* **21**, 239–257.
64. Fleming C, Hockey K, Schmeid V *et al.* (2020) Food and Me. How adolescents experience nutrition across the world. A Companion Report to The State of the World's Children 2019. Sydney: Western Sydney University and United Nations Children's Fund (UNICEF). doi: <https://doi.org/10.26183/26f6-ec12>.
65. Shannon C, Story M, Fulkerson JA *et al.* (2002) Factors in the school cafeteria influencing food choices by high school students. *J Sch Health* **72**, 229–234.
66. Sahota P, Woodward J, Molinari R *et al.* (2014) Factors influencing take-up of free school meals in primary-and secondary-school children in England. *Public Health Nutr* **17**, 1271–1279.
67. Gangemi K, Dupuis R, FitzGerald E *et al.* (2020) Youth speak out on school food environments. *J Sch Nurs* **36**, 193–202.
68. Ziegler AM, Kasprzak CM, Mansouri TH *et al.* (2021) An ecological perspective of food choice and eating autonomy among adolescents. *Front Psychol* **12**, 654139.
69. Murphy M, Mensah D, Mylona E *et al.* (2021) Acceptability and feasibility of strategies to promote healthy dietary choices in UK secondary school canteens: a qualitative study. *BMC Res Notes* **14**, 1–8.
70. Mohammadi S, Su TT, Papadaki A *et al.* (2021) Perceptions of eating practices and physical activity among Malaysian adolescents in secondary schools: a qualitative study with multi-stakeholders. *Public Health Nutr* **24**, 2273–2285.
71. Gilmour A, Gill S & Loudon G. (2021) Perspectives of UK catering staff on adolescents' food choices at school. *J Child Nutr Manag* **45**, n1. <https://schoolnutrition.org/journal/spring-2021-perspectives-of-uk-catering-staff-on-adolescents-food-choices-at-school/#full-article> (accessed July 2022).
72. Devine LD, Gallagher AM & Hill AJ (2021) Stakeholders' perspectives on improving adolescents' dietary behaviours in the school setting: a qualitative study. *Proc Nutr Soc* **80**, E142.
73. Devine LD, Gallagher AM & Hill AJ (2022) Current influences on adolescents' food choices within the school setting and opportunities for improvement: a qualitative study. *Proc Nutr Soc* **81**, E34.
74. Wills W, Danesi G, Kapetanaki AB *et al.* (2019) Socio-economic factors, the food environment and lunch-time food purchasing by young people at secondary school. *Int J Environ Res Public Health* **16**, 1605.
75. Ghaffar SA, Talib RA & Karim NA (2019) Food choices and diet quality in the school food environment: a qualitative insight from the perspective of adolescents. *Malays J Med Health Sci* **45**, 15.
76. McKinley MC, Lewis C, Robson PJ *et al.* (2005) It's good to talk: children's views on food and nutrition. *Eur J Clin Nutr* **59**, 542–551.
77. Wills W, Backett-Milburn K, Gregory S *et al.* (2005) The influence of the secondary school setting on the food practices of young teenagers from disadvantaged backgrounds in Scotland. *Health Educ Res* **20**, 458–465.
78. Addis S & Murphy S (2019) 'There is such a thing as too healthy!' The impact of minimum nutritional guidelines on school food practices in secondary schools. *J Hum Nutr Diet* **32**, 31–40.
79. Payán DD, Sloane DC, Illum J *et al.* (2017) Perceived barriers and facilitators to healthy eating and school lunch meals among adolescents: a qualitative study. *Am J Health Behav* **41**, 661–669.
80. Foley BC, Shrewsbury VA, Hardy LL *et al.* (2017) Evaluation of a peer education program on student leaders' energy balance-related behaviors. *BMC Public Health* **17**, 695.
81. Salvy SJ, de la Haye K, Bowker JC *et al.* (2012) Influence of peers and friends on children's and adolescents' eating and activity behaviours. *Physiol Behav* **106**, 369–378.
82. Chung SJ, Ersig AL & McCarthy AM (2017) The influence of peers on diet and exercise among adolescents: a systematic review. *J Pediatr Nurs* **36**, 44–56.
83. Ragelienė T & Grønhoj A (2020) The influence of peers' and siblings' on children's and adolescents' healthy eating behavior. A systematic literature review. *Appetite* **148**, 104592.
84. Kumar J, Adhikari K, Li Y *et al.* (2016) Identifying barriers, perceptions and motivations related to healthy eating and physical activity among 6th to 8th grade, rural, limited-resource adolescents. *Health Educ* **116**, 123–137.
85. Rathi N, Riddell L & Worsely A (2016) What influences urban Indian secondary school students' food consumption? – a qualitative study. *Appetite* **105**, 790–797.
86. Melo H, de Moura AP, Aires LL *et al.* (2013) Barriers and facilitators to the promotion of healthy eating lifestyles among adolescents at school: the views of school health coordinators. *Health Educ Res* **28**, 979–992.
87. WHO (2022) Health promoting schools. [https://www.who.int/health-topics/health-promoting-schools#tab=tab\\_1](https://www.who.int/health-topics/health-promoting-schools#tab=tab_1) (accessed August 2022).
88. Turunen H, Sormunen M, Jourdan D *et al.* (2017) Health promoting schools – a complex approach and a major means to health improvement. *Health Promot Int* **32**, 177–184.
89. Langford R, Bonell C, Komro K *et al.* (2017) The health promoting schools framework: known unknowns and an agenda for future research. *Health Educ Behav* **44**, 463–475.
90. Macnab AJ, Gagnon FA & Stewart D (2014) Health promoting schools: consensus, strategies, and potential. *Health Educ* **114**, 170–185.
91. Langford R, Bonell C, Jones H *et al.* (2015) Obesity prevention and the health promoting schools framework: essential components and barriers to success. *Int J Behav Nutr Phys Act* **12**, 1–17.
92. McHugh C, Hurst A, Bethel A *et al.* (2020) The impact of the World Health Organization health promoting schools framework approach on diet and physical activity behaviours of adolescents in secondary schools: a systematic review. *Public Health* **182**, 116–124.
93. Foster GD, Sherman S, Borradaile KE *et al.* (2008) A policy-based school intervention to prevent overweight and obesity. *Pediatrics* **121**, e794–e802.
94. Hoppu U, Lehtisalo J, Kujala J *et al.* (2010) The diet of adolescents can be improved by school intervention. *Public Health Nutr* **13**, 973–979.
95. Ensaff H (2021) A nudge in the right direction: the role of food choice architecture in changing populations' diets. *Proc Nutr Soc* **80**, 195–206.
96. Meiklejohn S, Ryan L, Palermo C *et al.* (2016) A systematic review of the impact of multi-strategy nutrition education programs on health and nutrition of adolescents. *J Nutr Educ Behav* **48**, 631–646.
97. Murimi AF, Moyeda-Carabaza B, Nguyen S *et al.* (2018) Factors that contribute to effective nutrition education interventions in children: a systematic review. *Nutr Rev* **76**, 553–580.
98. Kubik MY, Lytle LA, Hannan PJ *et al.* (2003) The association of the school food environment with dietary



- behaviors of young adolescents. *Am J Public Health* **93**, 1168–1173.
99. Bucher T, Collins C, Rollo ME *et al.* (2016) Nudging consumers towards healthier choices: a systematic review of positional influences on food choice. *Br J Nutr* **115**, 2252–2263.
100. Ensaff H, Homer M, Sahota P *et al.* (2015) Food choice architecture: an intervention in a secondary school and its impact on students' plant-based food choices. *Nutrients* **7**, 4426–4437.
101. Ensaff H & Altieri E (2022) Nudges to promote healthy eating in schools: policy brief. <https://www.who.int/publications/i/item/9789240051300> (accessed June 2022).
102. Quinn EL, Johnson DB, Podrabsky M *et al.* (2018) Effects of a behavioral economics intervention on food choice and food consumption in middle-school and high-school cafeterias. *Prev Chronic Dis* **15**, E91.
103. Spence S, Matthews JN, McSweeney L *et al.* (2022) The effect of a product placement intervention on pupil's food and drink purchases in two secondary schools: an exploratory study. *Nutrients* **14**, 2626.
104. Metcalfe JJ, Ellison B, Hamdi N *et al.* (2020) A systematic review of school meal nudge interventions to improve youth food behaviors. *Int J Behav Nutr Phys Act* **17**, 1–19.
105. Nørnberg TR, Houlby L, Skov LR *et al.* (2016) Choice architecture interventions for increased vegetable intake and behaviour change in a school setting: a systematic review. *Perspect Public Health* **136**, 132–142.
106. Yip C, Gates M, Gates A *et al.* (2016) Peer-led nutrition education programs for school-aged youth: a systematic review of the literature. *Health Educ Res* **31**, 82–97.
107. Evans CE (2020) Next steps for interventions targeting adolescent dietary behaviour. *Nutrients* **12**, 190.
108. GENIUS School Food Network (2022) Pump-Priming Awards. <https://geniusschoolfoodnetwork.com/Pump-primingAwards/> (accessed November 2022).
109. Sacco J, Lillico HG, Chen E *et al.* (2017) The influence of menu labelling on food choices among children and adolescents: a systematic review of the literature. *Perspect Public Health* **137**, 173–181.
110. Conklin MT, Cranage DA & Lambert CU (2005) Nutrition information at point of selection affects food chosen by high school students. *J Child Nutr Manag* **20**, 97–108.
111. Hunsberger M, McGinnis P, Smith J *et al.* (2015) Calorie labelling in a rural middle school influences food selection: findings from community-based participatory research. *J Obes* **2015**, 531690.
112. Rooney C, Neville CE, Hanvey J, *et al.* (2017) A qualitative investigation into the acceptability of a food-based rewards system in secondary schools. *Proc Nutr Soc* **76**, E118.